RE New Ecology reports Salish Sea Model Ocean Acidification and Sediment Flux modules.txt

From: Rappoli, Brian
Sent: Wednesday, July 12, 2017 8:15 AM
To: Fullagar, Jill; Adams, Angela; Anderson-Carnahan, Linda; Brown, Cheryl A.; Cope, Ben; Cora, Lori; Croxton, Dave; Davis, Michelle V.; Dunbar, Bill; Duncan, Bruce; Guzzo, Lindsay; Labiosa, Rochelle; Liebman, Matt; Littleton, Christine; Lohrman, Bridgette; Mlsna, Ivy; Nelson, Walt; Pacella, Stephen; Szelag, Matthew; Thompson, Brian; Ziegler, Sam
Subject: RE: New Ecology reports: Salish Sea Model – Ocean Acidification and Sediment Flux modules
Attachments: nanoos-workshop-jul2017-agenda-final.pdf

Hi everyone,

Another FYI.

Some of you may be interested in the NANOOS workshop – note the presentation by Burke Hales.

Regards,
Brian

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Sent: Tuesday, July 11, 2017 5:55 PM
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Subject: FW: New Ecology reports: Salish Sea Model – Ocean Acidification and Sediment Flux modules

Hi all,

Just fyi, regarding the Ecology OA model we've talked about.

jill

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Fyi.

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    Subject: New Ecology reports: Salish Sea Model – Ocean Acidification and Sediment
    Flux modules

    The report, Salish Sea Model: Ocean Acidification Module and the Response to
    Regional
    Anthropogenic Nutrient Sources, is available at
    https://fortress.wa.gov/ecy/publications/SummaryPages/1703009.html.

    The report, Salish Sea Model: Sediment Diagenesis Module, is available at
    https://fortress.wa.gov/ecy/publications/SummaryPages/1703010.html.

    Ocean Acidification Module

    Several monitoring programs indicate the presence of lower pH and related changes in
    carbonate
    system variables in the Salish Sea as compared to the shallow North Pacific waters
    offshore. Pacific Ocean waters are influenced by increasing global atmospheric
    partial pressure
    of carbon dioxide (pCO2) which has been identified as a dominant contributor to
    lower pH and
    related carbonate chemistry changes. However, local biological processes may also
    significantly
    contribute to the local values of pH and carbonate system variables. Thus, regional
    human
    nutrient contributions may exacerbate changes to the local carbonate system
    chemistry.

    Of specific interest are changes to the aragonite saturation state (?arag), a form
    of calcium

carbonate used by many shell-building organisms. If the ?arag is low or under-saturated, calcifying organisms may not be able to build shells, which could result in a cascade of impacts to the food web.

The present project examines how regional freshwater/land-derived sources of nutrients generally impact acidification in the Salish Sea. Regional human contributions of nutrients and carbon originate within the Puget Sound and Salish Sea watersheds.

This project expands the capabilities of the Salish Sea Model by adding total dissolved inorganic carbon (DIC) and alkalinity as state variables, including source and sink terms related to air-sea exchange, respiration, photosynthesis, nutrient gains and losses, sediment fluxes, and boundary conditions. Boundary conditions account for both Pacific Ocean upwelled water and regional human nutrient contributions and air emissions around the Salish Sea. This effort also identifies geographical areas and seasons experiencing greater influence from regional sources of nutrients to Salish Sea waters.

Results from this effort indicate that increased dissolved inorganic nitrogen (DIN),

phytoplankton biomass, and non-algal organic carbon caused by regional anthropogenic nutrient sources can constitute significant contributors to acidification in the Salish Sea. Predicted impacts due to regional anthropogenic nutrient sources include changes in pH and DIC in both bottom and surface waters that are comparable in magnitude to published estimates of the changes caused by increasing global atmospheric pCO2.

The ?arag decreased, on average, due to regional anthropogenic nutrient sources. The impact is predicted to be greatest at the bottom of the water column. Compared with published estimates of changes caused by global CO2, regional anthropogenic nutrient sources account for up to about 43% of the total depletion of ?arag at the bottom, and up to about 15% of the total depletion of ?arag at the surface. Anthropogenic nutrient loadings increased pH and ?arag in some areas,

particularly in several South Puget Sound shallow inlets and bays.

The ?arag in certain regions appears to be more sensitive to anthropogenic nutrient loadings. Specifically, portions of the main basin, South Sound, Port Susan, Skagit Bay, and
Whidbey Basin all present higher sensitivity of ?arag in response to anthropogenic nutrient
loadings. Hood Canal appears to be generally decoupled from the rest of the Salish Sea in terms
of the magnitude of anthropogenic, land-derived nutrient influence. This is likely due in part to
circulation and the lower level of development in the Hood Canal region.

Sediment Diagenesis Module

Low concentrations of dissolved oxygen (DO) have been measured throughout the Salish

Sea. Recent modeling investigations indicate that low concentrations occur throughout much of
the Salish Sea due to the intrusion of water with naturally occurring low DO from the Pacific
Ocean. However, some regions of Puget Sound are also significantly influenced by human
nutrient contributions. Sediment-water interactions strongly influence oxygen levels. A
previous version of the Salish Sea Model, which simulated Salish Sea hydrodynamics and water
quality, did not include the capability of dynamically simulating sediment-water interactions. Instead, it used a simpler approach of specifying sediment fluxes which limited our
ability to distinguish the effect of individual nutrient sources on sediment fluxes, and thus, on
DO levels in the Salish Sea.

This study added the capability to dynamically simulate the sediment-water exchanges into the
water quality dynamics of the model, through a process called sediment diagenesis. Material
fluxes to the sediment from the water column fuel biogeochemical processes that release some of
the nutrients back to the water column and consume oxygen in the process. We set up and tested
the model code to ensure that sediment-water exchanges were incorporated appropriately.

We applied the revised water quality model to the Salish Sea and compared simulation results
against monitoring data to assess the model skill, a process that required

recalibration. The
updated Salish Sea Model, including simulation of sediment diagenesis and fluxes of oxygen and
nitrogen between the water and sediment, was re-calibrated to the observed data. The model
skill with the new sediment flux module was comparable to the previous version of the model,
with improvement in skill for simulating DO levels in the lower ranges. Model skill in
predicting observed data is reasonable and acceptable.

The revised and recalibrated Salish Sea Model, which now includes sediment diagenesis, will be
used in future studies to reevaluate the relative influence on DO of climate effects, local human
nutrient sources, and the Pacific Ocean.

If you have questions, contact Greg Pelletier at 360-407-6485 or gpel461@ecy.wa.gov.

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